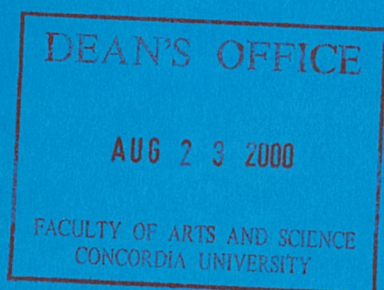


**CENTRE FOR STRUCTURAL AND
FUNCTIONAL GENOMICS**

FACULTY OF ARTS AND SCIENCE

CONCORDIA UNIVERSITY

**ANNUAL REPORT
1999-2000**



**PREPARED BY
DR. ADRIAN TSANG
DIRECTOR**

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Summary

The 1999-2000 academic year was the first full year of operation for the Centre for Structural and Functional Genomics. In the past year the Centre has made enormous progress towards the establishment of a research facility and in providing research training.

We received an institutional innovation grant of over three million dollars from the Canada Foundation for Innovation. Members of the Centre have also received several genomics grants and contracts.

Approximately 1,600 square feet of space on the twelfth floor of the Hall Building has been converted into a biotechnology laboratory, a bioinformatics laboratory, a computational server room and an image facility. This suite of rooms forms the core of the BioChem Pharma Genomics Facility.

Over \$1.2M have been used to acquire large and small equipment. Major instruments that have been acquired include an automated DNA sequencer, an analytical ultracentrifuge, a laser scanning confocal microscope, isothermal titration microcalorimeter, and a microarrayer for DNA chip technology.

The Centre has held over 20 seminars and workshops to promote genomics research, and to provide theoretical background and hands-on research training in the use of various instruments. Discussions are underway to turn the workshops into intensive, credited courses to be offered in May and September of each year.

A task force was set up to assess teaching programs in genomics and proteomics at the undergraduate and graduate levels. These are expected to be co op programs where the students will receive part of their research training in industrial and government laboratories.

Future plans include increasing the membership of the Centre, expanding the proteomics platform, and seeking additional funding for operation.

Introduction

In November 1998, the faculty council of Arts and Science approved the formation of the Centre for Structural and Functional Genomics. The aims of the Centre are to: 1) create an intellectual environment for interdisciplinary research on genomics; 2) establish infrastructures for biotechnology and bioinformatics; 3) foster collaborations and links with the industrial sector; and 4) support teaching programs and research training in genomics.

Genomics encompasses an extremely broad domain. The Centre promotes basic and applied research programs on model organisms and microorganisms of economic relevance. The research programs focus on five aspects of functional genomics: 1) gene discovery, 2) gene function and expression, 3) localization of gene products, 4) molecular interactions, and 5) bioinformatics. These areas are envisioned to provide a multi-faceted strategy needed to understand how organisms function at the molecular level. They also form the conceptual framework in the design of new products, in the improvement of industrial practices, and in devising new strategies to remove environmental wastes.

Through the Capital Campaign, Concordia received a donation of \$1M from BioChem Pharma Inc. and \$100,000 from Dr. Francesco Bellini to establish a genomics facility. Managing the BioChem Pharma Genomics Facility is one of the main responsibilities of the Centre.

Members and Personnel

Initial membership was solicited from members of the Faculty of Arts and Science who were interested in genomics research, committed to work in an interdisciplinary environment, and were members of existing research teams. Several researchers who did not fulfill all the above criteria were invited to join as associate members.

Full members:

Dr. Patrick Gulick, Department of Biology
Dr. Ragai Ibrahim, Department of Biology
Dr. Paul Joyce, Department of Chemistry and Biochemistry
Dr. Justin Powlowski, Department of Chemistry and Biochemistry
Dr. Reginald Storms, Department of Biology
Dr. Adrian Tsang, Department of Biology
Dr. Joanne Turnbull, Department of Chemistry and Biochemistry
Dr. Luc Varin, Department of Biology

Associate members:

Dr. Carolyn Beckman, Department of Biology
Dr. Howard Bussey, Department of Biology (McGill University)
Dr. Gregory Butler, Faculty of Engineering and Computer Science
Dr. Jack Kornblatt, Department of Biology
Dr. Clement Lam, Faculty of Engineering and Computer Science

The Centre provides support in biotechnology and bioinformatics. Our support staff is a mix of experienced technologists and trainees. Ms. Rawlings has been invaluable in maintaining records and facilitating the acquisition of equipment. In the past year, we encountered a high turnover of personnel primarily because our trained personnel were offered more lucrative positions elsewhere.

Biotechnology:

Nathalie Brodeur, B.Sc., January 2000 –
Marielle Carpenter, B.Sc., January 1999 – May 2000
Sonia Ruiz, M.Sc., January 1999 – February 2000
Alex Spurmanis, M.Sc., January 2000 –
Peter Ulyczyni, Ph.D., April 2000 –

Bioinformatics:

Ainsley Archer, M.Sc., January 2000 – April 2000
Shawn Delaney, M.Sc., January 1999 – May 1999
Peter Wilkinson, B.Sc., May 1999 –

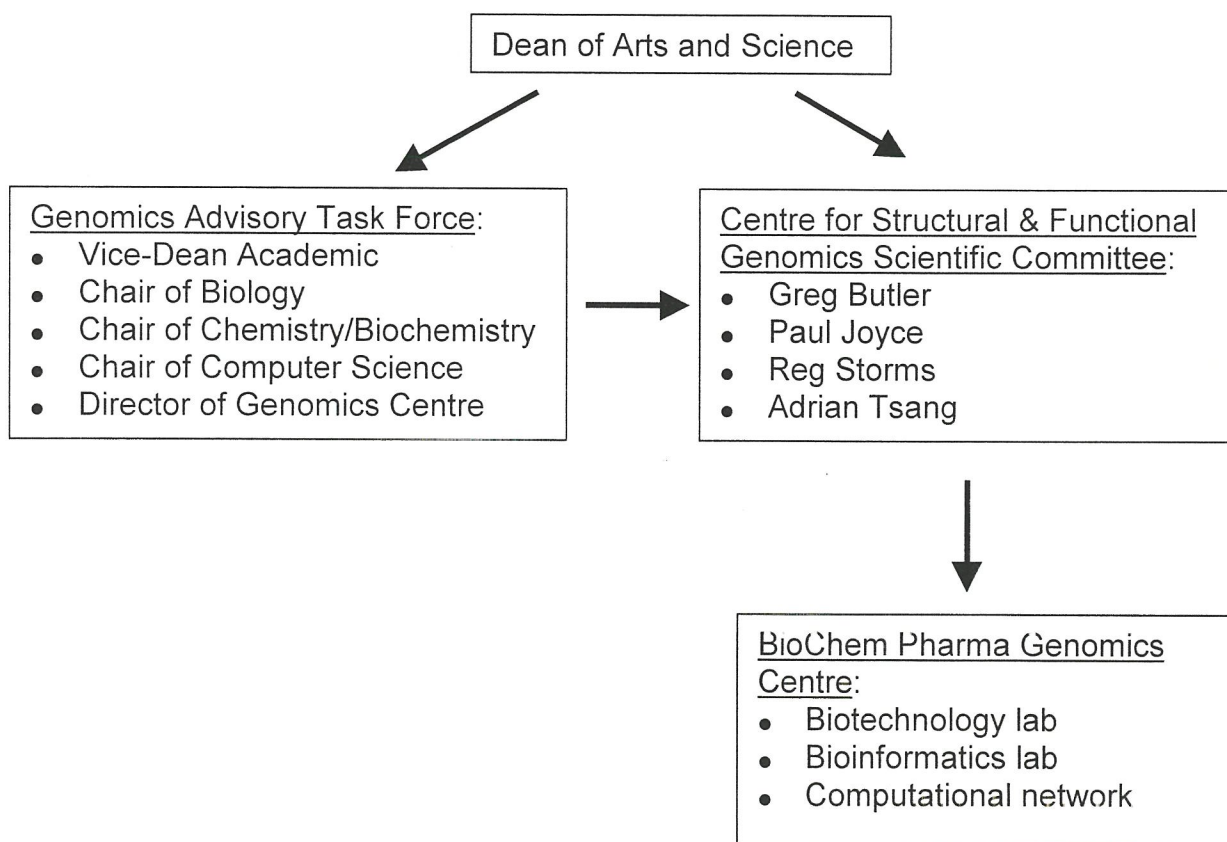
Secretary:

Kathryn Rawlings, March 1999 –

Management Structure

The management team is made up of a director and a scientific committee. Since inception, the director has been Dr. A. Tsang with Drs. G. Butler, P. Joyce and R. Storms as members of the scientific committee. The management team is in charge of all scientific aspects of the Centre including the management of the BioChem Pharma Genomics facility, initiating interdisciplinary research programs, promoting interactions between the Centre and other research institutions and industries, and designing interdisciplinary courses at the graduate and senior undergraduate levels. The director is responsible for the day-to-day operation of the Centre. The director reports to the Dean of Arts and Science.

In September 1999, Dr. M. Singer, the Dean of Arts and Science, set up a task force to assess the needs of genomics research and teaching at Concordia. The task force also serves as a liaison between the Centre and other academic units in the University. The diagrams below illustrate the relationships among the various entities.



BioChem Pharma Genomics Facility

In November 1999, Mr. Charles Emond, the Vice-Rector Services, approved the conversion of two classrooms on the 12th floor of the Hall Building into laboratories for the BioChem Pharma Genomics Facility. In January 2000, Mr. Emond finalized arrangements with the Registrar to accommodate courses that occupied these rooms. The two adjoining classrooms (H1221 and H1223) have a total space of 1,600 square feet. Dr. Martin Singer and Dr. Robert Roy, Dean and Vice-Dean Academic respectively, of Arts and Science allocated funds to construct an instrument room for biotechnology, a bioinformatics laboratory, a room for a computational server, and a microscopy room (to house a laser scanning confocal microscope, a fluorescence microscope and a micromanipulator). Construction began in late January under the supervision of Mr. Marc-André Loignon, an architect of Facilities and Planning. Mr. Claude Lamarche, the technical officer of Arts and Science, assisted in the acquisition of furniture. Major structural changes were completed in early April. Minor alterations continue as instruments are being installed. As we had excellent and close working relationships with Mr. Loignon and Mr. Lamarche, construction of the laboratories proceeded very smoothly and to specifications.

The current arrangement is a temporary home for the facility. We are expected to move into the new science complex at Loyola campus in 2002-2003. The Centre has been allocated over 7,000 square feet of laboratory and office space. It will have the following components: a biotechnology laboratory with two coldrooms and a radioisotope facility; three instrument rooms; a bioinformatics laboratory; a room for computational servers; an image facility with a darkroom and two microscope rooms; two environmental rooms for plant tissue culture and transfer; a level 3 containment facility; a cell technology facility with a kitchen, cell culture rooms and a preparation area; and an office suite. Additional details of the planned facility can be found in Appendix I.

Research Support

Infrastructure grant:

With the donations from BioChem Pharma, Inc. and Dr. F. Bellini as matching funds we applied for an institutional innovation grant from the Canada Foundation for Innovation (CFI). We were awarded \$1,246,080 by CFI and a matching \$1,246,080 by the Ministry of Education of Quebec. Seven hundred thousand dollars of the award are to be spent on the construction of the new facility, and the remaining for equipment acquisition.

Research grants and contracts:

Research support for members (underlined) of the Centre are listed below in alphabetical order.

Gulick, P., NSERC Research Grant "Signalling and the genetics of salt stress tolerance in *Lophopyrum elongatum* and bread wheat", 2000-2004, \$32,000/year

Ibrahim, R., NSERC Research Grant, "Biochemistry and molecular biology of plant metabolism", 1998-2002, \$51,750/year.

Ibrahim, R., Natural Resources Canada, "Purification and characterization of a novel flavonol dioxygenase", 1999-2000, \$12,000/year

Ibrahim, R., Natural Resources Canada, "Molecular cloning and functional expression of a flavonol glucosidase acyltransferase", 2000-2001, \$15,000

Joyce, P., NSERC Research Grant, 'Protein targeting in plant cells', 1999-2003, \$38,745/year

Joyce, P. and Powlowski, J., NSERC Genomics Grant, "Structural and functional genomics of aromatic degradation in the model yeast, *Trichosporon cutaneum*", 2000-2003, \$76,500/year

Matton, D., Gulick, P. and Brisson, N. NSERC Genomics Grant, "Genomic analysis of signaling during embryogenesis and defense response in potato", 2000-2003, \$154,000/year

Powlowski, J., NSERC Operating Grant, "Molecular mechanisms of bacterial phenol degradation and mercuric ion detoxification", 1998-2002, \$42,000/year

Eltis, L., Sylvestre, M., Powlowski, J. and Snieckus, V., NSERC Strategic Grant, "Engineering metabolic pathways for PCB degradation", 1999-2002, \$274,070/year

Peslherbe, G., Gadosy, T., Powlowski, J. and Turnbull, J., GRF (Concordia),

"Graphics workstation for molecular modeling", 1999-2000, \$7000/year

Sarhan, F., Gulick, P., Huener, N., Fowler, B. and Simmonds, J. NSERC Genomics Grant, " Functional genomics and mapping of stress regulated genes in cereals", 2000-2003, \$114,000/year

Storms, R., NSERC Research Grant, "Gene expression in *Saccharomyces cerevisiae*", 1999-2003, \$31,680/year

Storms, R., Mycota Biosciences research contract, \$30,000

Storms, R., Bussey, H. (P.I.), MRC Operating Grant, "A complete set of yeast gene disruptions", \$154,000/year, 1998-2001

Storms, R. and Tsang, A. NSERC Collaborative Research & Development Grant, "Expression systems for *Aspergillus niger*", 1998-2001, \$108,000/year

Storms, R., Bussey, H. and Tsang, A., FCAR Team Grant, "Genome wide approaches to determining gene function in model eukaryotes, 1998-2001, \$45,000/year

Tsang, A. NSERC Research Grant, "Protein-protein interaction", 1997-2001, 23,000/year

Tsang, A. Gist-brocades (DSM Biologics) research contract US\$50,000

Tsang, A., Butler, G., Joyce, P., Lam, C., Storms, R. and Turnbull, J., FRDP Inter-disciplinary Grant, "Bioinformatics infrastructure for genomics research", 1997-99, 45,000/year

Turnbull, J.L., NSERC Research Grant, "Active Site Studies on Multi-Domain Enzymes", 1997-2001, \$37,653/year

Varin, L., NSERC Research Grant, "Biochemistry and molecular biology of enzymatic sulfation in plants", 1998-2002, 52,100/year

Varin, L., Novartis research contract, 144,000/year

Equipment Acquisition

One of the main responsibilities of the Centre is to manage the BioChem Pharma Genomics Facility. Acquisition of large and small equipment constitutes the major activity in our first year of operation. Purchase of large instruments involved all members of the Centre and was a multi-step process. First we identified all available manufacturers and compared the specifications of the instruments. We attended workshops and demonstrations of the instruments. Where feasible we gained hands-on experience with the instruments. This process can be illustrated by the acquisition of the laser scanning confocal microscope. We formed an ad hoc committee made up of Drs. P. Joyce, R. Storms and A. Tsang. We also asked two outside experts of confocal microscopy, Dr. Paul Lasko and Dr. Beat Suter of the Biology Department of McGill University, to assist us in making our evaluation. We examined the specifications of available confocal microscopes and identified two models. We invited technical experts of the two manufacturers to present formal workshops. The workshops were attended by members of the Centre as well as researchers from Biology (Concordia and McGill), Chemistry and Biochemistry, and Psychology. For one manufacturer, a hands-on demonstration was held at Concordia for one week. Drs. Lasko and Suter had in-depth knowledge of the other model. We decided on the specifications and then sought the help of the Purchasing Department to seek tenders and the best price.

The purchase of each major instrument was an elaborate process that took as long as 6 months. It also involved the training of support staff. Listed below are major pieces of equipment acquired in the past year.

EQUIPMENT	LOCATION
Leica laser scanning confocal microscope	1223-2
Beckman Optima XLI analytical ultracentrifuge	1221
Beckman J-201 high capacity centrifuge	1221
Beckman J-301 superspeed centrifuge	1221
Capillary electrophoresis automated DNA sequencer	1221
ESI DNA Micro arrayer	1221
Isothermal titration microcalorimeter (Microcal)	1221
Fluorescence & visible imaging system	1239
Multitask plate reader (fluorescence/ luminescence/ absorption)	1221
Micromanipulator (Singer)	1223-1
Pulse-field electrophoresis chiller system (BioRad)	1221
Environmental shakers (2X)	1221
Computer workstations (16 stations and servers)	1221/ 1223/ 1239

Operation and Maintenance

Researchers in biotechnology and bioinformatics from all sectors in the Montreal area have access to the facility. The use of equipment is booked through the support staff. User fees are charged to cover the cost of maintenance and upgrades. Since all the instruments have a one-year warranty, Concordia users have free use of the instruments during the first year of operation.

Technical support:

The technical staff provides technical training to researchers and graduate students. For occasional users, the technical staff performs the operations. Each biotechnologist is in charge of a group of instruments.

Resource personnel:

For each major piece of equipment, at least two experts serve as resource personnel. They assist researchers in the design and execution of experiments. They also help the researchers in the interpretation of results.

Monitoring the use of equipment:

We configured a dedicated computational server "Adenine" to monitor usage of instruments that can be operated through Windows NT or Linux. Each user is given a password and the instruments can be operated only when an appropriate password is registered. Logbooks are used to monitor usage for the other instruments.

Summary of operation of selected major equipment

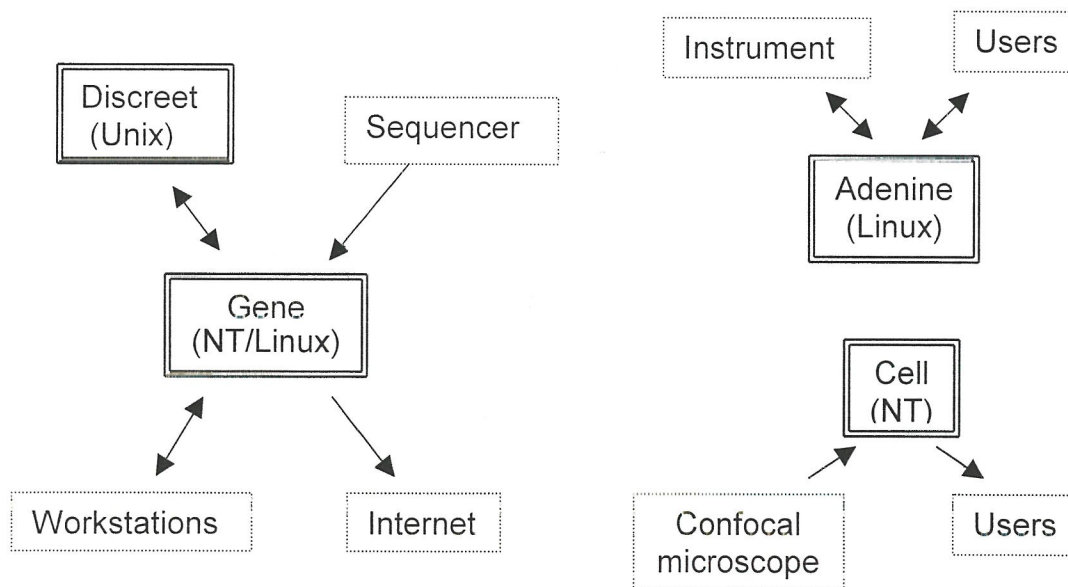
Equipment	Technical staff	Resource personnel	User fee
Analytical ultracentrifuge	P. Ulyczyni	J. Powlowski J. Turnbull	\$150 per day
DNA sequencer	N. Brodeur	R. Storms A. Tsang	\$1500 / 96 reactions
Isothermal titration microcalorimeter	P. Ulyczyni	J. Kornblatt L. Varin	\$60 per sample
Laser scanning confocal microscope	A. Spurmanis	P. Joyce A. Tsang	\$50 per hour
Microarrayer	A. Spurmanis	R. Storms A. Tsang P. Gulick	dependent on project size
Gene scanner	P. Ulyczyni	G. Butler L. Varin P. Gulick	\$50 per slide

Bioinformatics Infrastructure

Bioinformatics is an integral part of genomics. In addition to \$300,000 to acquire workstations in our infrastructure project, CFI also funded over \$2M towards the acquisition of a high performance computer (HPC) for Concordia. The Mechanical Engineering Department headed the HPC proposal. The Genomics Centre has a 25% share in the use of this computer. As the HPC is unlikely to be installed before 2002, we are currently using a DEC alpha system as our main server.

Dr. Greg Butler is in charge of the overall development of the bioinformatics infrastructure while Dr. Carolyn Beckman oversees the network development and security. In addition to the DEC alpha (Discreet) which is a Unix system, we have set up two servers functioning in Windows NT and Linux environment (Gene and Adenine) and 8 workstations. "Gene" is a general server and it forms a link between "Discreet" and the outside world. "Adenine" is an administrative server dedicated to monitor the usage of instruments. A fourth server "Cell" is being developed to communicate between the laser scanning confocal microscope and its users.

Software for DNA sequence analysis and protein structure determination that is installed in the various servers includes the following packages: Staden, MOE, and Seals. We have also developed a pipeline between the DNA sequencer and the server "Gene" such that quality control and initial analysis of raw data can be handled automatically.



Research Programs

Genomics research in the Centre is divided into five platforms: 1) gene discovery program, 2) gene function and expression, 3) localization of gene products, 4) molecular interactions, and 5) bioinformatics. Summary of the programs and project is outlined below.

Program	Projects	Investigators
Gene discovery	Expression sequence tags of filamentous fungus <i>Aspergillus niger</i>	Tsang, Storms, Butler & Lam
	Structural and functional genomics of aromatic degradation in the model yeast, <i>Trichosporon cutaneum</i>	Joyce & Powlowski
	Expression sequence tags of wheat	Sarhan, Gulick et al.
	Expression sequence tags of potato	Matton, Gulick et al.
Gene function and expression	Expression system of <i>Aspergillus niger</i>	Storms & Tsang
	Genome-wide approaches to gene function in model organisms	Storms, Tsang & Bussey
	Yeast gene disruption	Storms & Bussey
	Micro array analysis for identification of pathways and regulators	Matton, Gulick, Sarhan et al.
Localization of gene products	Localization of GFP fusion proteins	Joyce, Storms, Tsang
Molecular interactions	protein-protein interactions	Gulick, Joyce, Storms, Tsang
	protein-ligand interactions	English, Kornblatt, Powlowski, Turnbull
	Protein-DNA interactions	Storms, Tsang, Varin
Bioinformatics	Internet, database and software technology applied to bioinformatics	Butler, Bornberg-Bauer, Grahne, Kurfess, Lam, Paquet, Rojas, Shingal, Tao and Tsang

Research Training

Training of highly qualified personnel is a high priority for the Centre. In addition to graduate students, postdoctoral fellows and research assistants, we have offered research training to senior undergraduate students and internships to DEC and exchange students. The Centre encourages co-supervision of students and co-op training involving industrial and government laboratories.

Ph. D. students

Name	Project	Supervisor(s)
Anzellotti, Dominique	Cloning of flavonol 6-hydroxylase	Ibrahim
Cadieux, Elizabeth	Characterization of DmpM, the activator protein of multicomponent phenol hydroxylase	Powlowski
Gaudet, Pascale	Cellular responses to DNA damage	Tsang
Gidda, Satinder	Molecular and biochemical characterization of a sulfotransferase which modulates flowering in <i>A. thaliana</i>	Varin
Nathalie Imbeault	Characterization and engineering of biphenyl dioxygenase	Powlowski
Kalant, David	Characterization of the ASP receptor	Cianflone, Joyce
Marsolais, Frederic	Molecular characterization of four members of the steroid sulfotransferase family from <i>Brassica napus</i>	Varin
Munroe, Edith	Structure function studies of thymidylate synthase	Storms
Wei, Shen	Signalling in the salt stress response	Gulick

M.Sc. students

Name	Project	Supervisor(s)
Au, Catherine	Molecular analysis of <i>trans</i> -acting transcription regulators of the GlaA gene from <i>Aspergillus niger</i>	Storms, Tsang
Aumont, Roch	DNA shuffling to evolve variants of biphenyl dioxygenase	Powlowski
Dodard, Sabine	The use of enchytraeids to study the biochemical and ecotoxicological effects of recalcitrant environmental pollutants on soil invertebrates	Powlowski, Sunahara, G.
Elias, Demetra	Protein Kinase interactions	Gulick

El-Khairi, Dina	O-methylation of flavanoids	Gulick, Ibrahim
Gu, Jun	Identification of proteins interacting with lupin and Arabidopsis tRNA nucleotidyltransferase	Joyce
Haque, Takrima	Fourier Transform infrared (FTIR) spectroscopy studies on aspartate transcarbamylase using isotope editing	Turnbull
Karam, Fouad	Location of tRNA nucleotidyltransferase in lupin	Joyce
Liu, Jianguo	Targeting of tRNA nucleotidyltransferase in <i>Arabidopsis</i>	Joyce
Padovani, Alessandra	The role of cysteine residues in the mechanism of chorismate mutase-prephenate dehydrogenase	Turnbull, J.
Piot, Frederic	Gene expression and signalling	Gulick
Reich, Jennifer	Functional analysis of genes within a duplication found on CHXV and CH1 of <i>Saccharomyces cerevisiae</i>	Storms
Russo, Kathy	Regulation of the oxytocin receptor	Turnbull
Seo, Jung Hwa	Ribonucleotide reductase interacting proteins	Tsang
Tkatcheva, Anastassia	Studies on the regulation of expression of 12-hydroxyjasmonate sulfotransferase from <i>Arabidopsis thaliana</i>	Varin
Zhang, Yun	Regulation of glycine cleavage activity in <i>Saccharomyces cerevisiae</i>	Storms

Postdoctoral fellows

Name	Project	Supervisor(s)
Hernandez-Sebastia, Cinta	Novartis contract	Varin
Ismoyo, Fenny	Investigation of protein structure under selected physico-chemical conditions by circular dichroism and FTIR	Turnbull, Ismail, A.
Li, Hongshan	Molecular characterization of gene expression in <i>Aspergillus niger</i>	Storms, Tsang
Muzac, Ingrid	O-methyltransferase expression	Ibrahim
Schleiff, Enrico	Protein import into mitochondria: a study on hTom20	Turnbull, Shore, G.
Spertini, Diego	Novartis contract	Varin

Ulyczyni, Peter	Development of a highly parallel system for drug-specific cellular targets	Storms
Vedadi, Masoud	Engineering microorganisms for PCB degradation	Powlowski

Research assistants

Name	Project	Supervisor(s)
Beliveau, Dominic	Purification and characterization of H189N mutant of a bifunctional enzyme	Turnbull
Doquang, Kimchi (B.Sc.)	Cell cycle regulation	Tsang
Martinez-Perez, Amalia (M.Sc.)	Protein expression in <i>Aspergillus niger</i>	Storms, Tsang
Sillaots, Susan (M.Sc.)	Improvement of <i>Aspergillus niger</i> strains	Storms, Tsang
Tito, Donald	Various projects	Powlowski

Undergraduates and interns

Name	Program	Supervisor(s)
Aponte, Raphael	Chemistry undergraduate thesis	Powlowski
Beliveau, Dominic	Biology undergraduate thesis	Turnbull
Bourbeau, Marc	Chemistry co-op	Turnbull
Bovin, Julie	Internship, l'Université de Lyon I	Turnbull
Boyd, Jason	Biology undergraduate thesis	Varin
Brunetti, Donato	NSERC summer scholarship	Tsang
Campbell, Catherine	Chemistry undergraduate thesis	Turnbull
Dufresne, Marie-Helene	NSERC summer studentship	Joyce
Filosi, Serena	Chemistry co-op	Turnbull
Fisher, Mathew	Delta DEC internship	Butler, Tsang
Guyon, Sebastien	Internship, l'Université de Lyon I	Turnbull
Hambly, David	Biochemistry undergraduate thesis	Joyce
Hassan, Sylvie	Biochemistry undergraduate thesis	Butler, Tsang
Lackmann, Rebecca	Biochemistry co-op	Tsang
MacPherson, Sarah	Biology undergraduate thesis	Tsang
Noce, Anthony	Biochemistry undergraduate thesis	Ibrahim, Gulick
Nouguerede, Emilie	Internship, Université d'Aix-Marseille II	Tsang
Solis, Mayra	NSERC summer scholarship	Turnbull
Sundaram, Jay	NSERC summer scholarship	Butler, Storms, Tsang
Visomblin, Nathalie	Internship, Université d'Orleans	Tsang

Seminars and Workshops

Seminars and workshops are essential parts of research training. They also help to promote the activities of the Centre. Seminars are open to the public and are usually 50 minutes in duration with 10-15 minutes of discussion. Workshops are targeted mainly to members, staff and students of the Centre. They usually consist of 1 hour of formal presentation with 1-3 hours of informal discussions.

The Centre does not have a budget for seminars and workshops. Promotion costs of the other seminars were borne by the hosts. Dr. E. Newman of the Biology Department was particularly generous in hosting seminars for the Centre.

Seminars Held:

Dr. Hans van den Homberg, DSM Gist-brocades, Delft, the Netherlands

Host: A. Tsang

"Towards a new standard in microbial protein production technology, STIP Technology"

May 21, 1999

Dr. Janette Carey, Princeton University

Host: E. Newman

"Affinity and specificity mechanisms of DNA-Binding proteins"

June 21, 1999

Dr. Terrance G. Cooper, University of Tennessee-Memphis

Host: E. Newman

"The GATA factors of *Saccharomyces cerevisiae*: genome-wide transcription regulators"

July 9, 1999

Dr. Martha M. Howe, Ph.D., University of Tennessee-Memphis

Host: E. Newman

"Activation of transcription during lytic development of bacteriophage Mu: Mutational analysis of the activator protein C and its interaction with the late promoter Plys"

July 9, 1999

Dr. Birgit Wetterauer, Zoologisches Institut, Ludwig-Maximilians-Universität

Host: A. Tsang

"The decision between growth and development in the social amoebae *Dictyostelium discoideum*"

August 13, 1999

Dr. Dinesh Christendat, Ontario Cancer Institute
Host: J. Turnbull
"Structural Proteomics of a Thermophile"
March 13, 2000

Dr. Costas Karatzas, Nexia Biotechnologies Inc.
Host: R. Storms
"Animal Transgenics: Producing the next generation recombinant proteins"
JUNE 2, 2000

Prof. Akira Ishihama, National Institute of Genetics, Mishima, Shizuoka, Japan
Host: E. Newman
"Molecular anatomy and assembly of transcription apparatus: RNA polymerases
of *E. coli* and *S. pombe*"
June 21, 2000

Workshops held:
Scott Levy, Packard Instrument Company
Piezoelectric Biochips Systems
January 21, 1999

Stephen Robinson, Beckman Instruments Inc.
CEQ 2000 DNA Sequencer
February 22 and 23, 1999

Guy Beaudoin, Varian Canada
Cary 50 Spectrophometer
March 9, 1999

Dr. Adrian Tsang, CSFG
Automated DNA Sequencing
April 22, 1999

Stephen Robinson, Beckman Instruments Inc.
Sequence data analysis and manipulation
April 22, 1999

Steven Eaton from MicroCal
Isothermal titrating microcalorimeter (ITM)
July 7, 1999

Claudia Di Schiavi, EG&G Wallace
Hosts: Christine Sarafian and Sylvain Brault, Fisher Scientific
Victor 1420 Multimask Plate Reader
August 12, 1999

Hubert Caniglia, Orion Research Inc.
Host: Christine Sarafian, Fisher Scientific
Sensorlink data acquisition system for DO and pH determination
August 18, 1999

Dr. Vladimir Zhukarev, Leica
Confocal microscopy: theory and practice
October 28, 1999

Dr. Joanne Turnbull, CSFG
CMPD, AUC, ITC, etc.
November 1, 1999

Christopher Kay, Carl Zeiss Canada Ltd.
Confocal Microscope
November 18, 1999

Dr. Muriel Herrington, Biology, Concordia University
Data Mining in Genomics
November 29, 1999

Dr. Jack Kornblatt, Biology, Concordia University
Isothermal Titrating Calorimetry
December 13, 1999

Vladimir Zhukarev and Brad Kalaway, Leica Microsystems Inc.
Confocal Microscope demonstration
January 11-13, 2000

Dr. Ann English, Chemistry and Biochemistry, Concordia University
Uses of Mass Spectrometry in Protein Analyses
February 28, 2000

Dr. Greg Butler, Computer Science, Concordia University
"The GeneQuiz system from EMBL for assigning function to genes"
MARCH 27, 2000

Michael Schroeder, Beckman Coulter
XL-I Analytical Ultracentrifuge
April 11, 2000

Sylvain Brault, Fisher Scientific
SynGene "Genome" Image documentation system
April 20, 2000

Serge Pinneault, Canberra Packard Canada
FluorChem 8000 Image Documentation System
May 17, 2000

Laura Sullivan, SynGene
Host: Christine Sarafian, Fisher Scientific
"Gene Gnome" Image Documentation System

Collaborations and Linkages

A mission of the Centre is to foster collaborations and linkages with other institutions and other sectors. The Centre had been extremely active in forming collaborations and networks.

Genome Quebec:

Genome Quebec is expected to be a network of Centres and genomics researchers with funding from Genome Canada and the Government of Quebec. Dr. A. Tsang is a member of the scientific committee of Genome Quebec. Dr. J. Lightstone (Provost/Vice-Rector-Research) and Dr. C. Bédard (Dean of Graduate Studies and Research) are our institutional representatives in the establishment of Genome Quebec. Dr. M. Singer and Dr. R. Roy of Arts and Science are kept informed of the detailed development by e-mail messages and telephone conversations. In response to the initial call for proposals in January 2000, Concordia's researchers submitted nine research proposals to Genome Quebec. We expect to be active participants of Genome Quebec when it is established.

Collaborations with other institutions:

We held talks with representatives of UQAM to examine the feasibility of consolidating the technical expertise in our facilities. Further discussions will depend on the ability of UQAM to secure funding from CFI. At present, members of the Centre are collaborators with researchers from other institutions in several funded projects. We expect the number of these collaborations to increase as the Centre matures.

- with McGill University – “Genome-wide approaches to gene function in model eukaryotes” and “A complete set of yeast gene disruptions”

- with Université Montréal – “Genomic analysis of signaling during embryogenesis and the defense response in potato”

- with UQAM, University of Saskatchewan, Agriculture Canada and University of Western Ontario – “Functional genomics and mapping of stress regulated genes in cereals”

- with UQAM – “Biochemical characterization of a two-domain, salt-inducible cDNA clone encoding the N-methylation of P-ethanolamine and C-methylation of steroids”

Linkages with industrial sector:

To foster collaborations with the private sector, we held numerous discussions with biotechnology and bioinformatics corporations including BioChem Pharma, DSM Biologics, Nexia Biotechnology, Novartis, Parke-Davis, the Pulp and Paper Research Institute of Canada (PAPRICAN), and DNA Landmarks (BASF). We

expect most of these initiatives to result in collaborative research or the formation of partnerships. In the past year, we had joint research with:

- DSM Biologics (Gist-brocades) research contract
- Nexia Biotechnology – NSERC Collaborative Research & Development Grant
- Novartis research contract
- Mycota Biosciences research contract

Consultations with private sector:

Through Dr. J. Lightstone and Dr. M. Singer, we solicited help from Montreal TechnoVision to assess the support from the government and the biotechnology industry for teaching and training programs in genomics. The analysis of Montreal TechnoVision suggested that there is a severe shortage of highly qualified personnel in biotechnology in the Montreal area.

Contributions and Impact

Dissemination of research results took the form of publications, conference contributions and book edition.

Publications:

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Munro, E.M., Climie, S., Vandenberg E. and Storms, R.K. (1999) "Deletion of eukaryote-specific inserts in thymidylate synthase of *Saccharomyces cerevisiae*: In vitro and in vivo effects on enzyme activity". Biochimica et Biophysica Acta 1430:1-13.

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Gaudet, P., MacWilliams, H. and Tsang, A. Inducible expression of exogenous genes in *Dictyostelium discoideum* using the ribonucleotide reductase promoter (submitted to Nucleic Acids Research)

Gorr, S-U., Jain, R.K., Kuehn, U., Joyce, P.B.M., Cowley, D.J. Comparative sorting of neuroendocrin secretory proteins: the search for common ground in different sorting models and mechanisms. (submitted to Molecular and Cellular Endocrinology)

Harris, T.J.C., Awrey, D.E., Cox, B.J., Tsang, A. and Siu, C. -H. The Contact Site A Glycoprotein gp80 Initiates Construction of an Adhesion Complex from Raft-Like Precursors in *Dictyostelium discoideum* (submitted to the Journal of Cell Biology)

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Other impacts:

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Varin, L. and Gidda, S. (1999) Methods and composition to modulate flowering in plants. (patent)

Direct and Indirect Support

Faculty support:

The faculty of Arts and Science provides financial support for all its Centres. The Centre for Structural and Functional Genomics received \$45,000 from the Faculty for salaries and benefits of a biotechnologist and a part-time secretary.

Indirect cost of research:

The Faculty of Arts and Science and the academic departments receive a portion of the research overhead providing by the provincial government. Through this program the Faculty transferred \$10,000 to the Centre while the two participating departments – Biology and Chemistry/Biochemistry - transferred \$5,000 each to the Centre.

Contract overhead:

The University typically charges 40% of the project costs of research contracts as overhead. Approximately 25% of this overhead money is distributed to the Faculty that generates the contracts. We made a formal arrangement with the Faculty of Arts and Science to have the entire Faculty's portion of contract overhead, generated by the Centre's members, transferred to the Centre. This amounted to \$10,350.00.

User fees:

User fees are charged for the usage of instruments. In the first year of operation we charged user fees only on the DNA sequencer to cover reagent costs. This amounted to \$3,881.00.

In-kind support from participating departments:

Under our agreement in the CFI proposal, the participating Departments had pledged in-kind technical support for the Centre. The Biology Department had transferred Mr. A. Spurmanis to provide technical support for the Centre. Mr. Spurmanis started working part-time in the Centre from January 2000 and became a full-time staff in June 2000.

Summary of cash support

Source	Amount
Faculty of Arts and Science	\$45,000.00
Overhead on research grants	\$20,000.00
Contract overhead	\$10,350.00
User fees	\$3,881.00
Total	\$79,231.00

Future Plans

Besides continuing our course in the establishment of the genomics facility and forging additional links, we plan to expand our proteomics technology platform and to prepare for programs in genomics at the graduate and undergraduate levels.

Proteomics technology platform:

Last year, members of the Centre joined Dr. A. English of the Department of Chemistry/Biochemistry in an application for two mass spectrometers and ancillary equipment to expand our proteomics technology platform. We submitted the application to NSERC. Though we received favorable reviews, our grant application was not funded. We intend to re-submit to NSERC as well as applying to CFI for support.

Graduate and undergraduate programs in genomics:

We submitted a draft proposal to offer graduate and undergraduate programs in genomics and proteomics Dr. J. Lightstone and Dr. M. Singer in June 1999. We received strong support from both senior administrators. Dr Lightstone requested an assessment of these programs by Montreal TechnoVision. Dean Singer formed a task force to assess the resource implications of such programs. The Centre submitted several drafts to the task force for discussion. The final discussion document was presented to Dr. R. Roy, the head of the task force. Dr. Roy is expected to submit this document (Appendix II) along with cost assessment to Dean Singer.

In anticipation of forming the new programs, we will hold discussions with the participating departments (Biology, Computer Science, and Chemistry/Biochemistry) to prepare for course and program changes. We expect to implement the changes beginning in the fall term of 2001 and admit students to the new programs in the fall term of 2002.

University Research Centre status:

We have recently approved the application for full membership from Dr. Ann English (Department of Chemistry/Biochemistry), Dr. Gregory Butler and Dr. Clement Lam (Department of Computer Science). In the Fall of 2000 we plan to apply for University Research Centre with the expanded membership. We will seek financial support from FCAR in 2001. Also, we are requesting funds from Genome Quebec to provide operating costs for our research facility.

Appendix I

Plans for New Genomics Facility

Concordia University • Functional & Space Program

Proposed Areas

DRAFT

Faculty of Arts and Science

Revised May 29, 2000

Centre for Structural and Functional Genomics

Category	Room Number		Room Name	Qty	Areas (m ²)		Comments
	Existing	Proposed			Unit	Total	
Office							
							6.0 support staff: (2 sec, 6 research tech.)
0300			Reception	1	15	15	Includes workstation for a secretary
0300			Office, Director's Secretary	1	10,5	10,5	
0300			Office, Director	1	17,5	17,5	With table seating 4
0300			Office, Technician	3	10,5	31,5	2 technicians per office
0300			Office, Visiting researcher	2	10,5	21	
0300			Filing area	1	2,5	2,5	For 6 file cabinets (43x90 cm)
0300			Conference room	1	30	30	Seating 15 persons
0300			Lecture room	0,3	66	19,8	Seating 40 persons with moveable tables and chairs, seminar, classroom style, to share
0300			Filing, storage and photocopy rm	1	15	15	
			Sub Total			159,5	
Research							
0400			Biotechnology laboratory	1	90	90	
0400			Radioisotope room	1	15	15	Adjacent to Biotech. Lab
0400			Cell culture prep. room	1	15	15	Adjacent to cell culture rms
0400			Cell culture rooms	2	15	30	Adjacent to prep. room
0400			Cell culture kitchen	1	25	25	Adjacent to prep. room
0400			Instrument room	3	30	90	
0400			Environmental room	2	12	24	
0400			Image Ctr & Microscope rm	1	20	20	
0400			Microscope room	1	20	20	
0400			Cold room	2	15	30	Walk-in type
0400			P3 Facility (containment)	1	25	25	Containment level 3
0400			Bioinformatics laboratory	1	75	75	
0400			Computer server room	1	10	10	Adj. to Bioinformatics room
			Sub Total			469	463 according to the Master Plan

Concordia University • Functional & Space Program

Proposed Areas

DRAFT

Faculty of Arts and Science

Revised May 29, 2000

Centre for Structural and Functional Genomics

Category	Room Number		Room Name	Qty	Areas (m ²)		Comments
	Existing	Proposed			Unit	Total	
0300			Office, Research chair	1	10,5	10,5	Anticipated 21st Century grant
0300			Graduate Student Office	1	10,5	10,5	
0300			Office, Post-Doc Fellow	1	10,5	10,5	
0300			Office, Research assistant	1	10,5	10,5	
0400			Research Lab.	1	70	70	
Sub Total						112,0	

Common rooms

0900			Kitchenette/Lunch Room	1	3	3	Contiguous to lounge and conference room
0900			Faculty lounge	1	10	10	Close to admin. Area

Sub Total 13

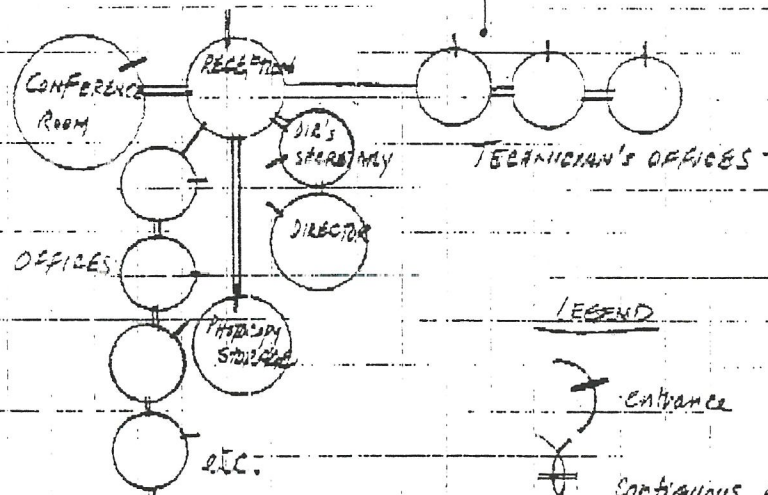
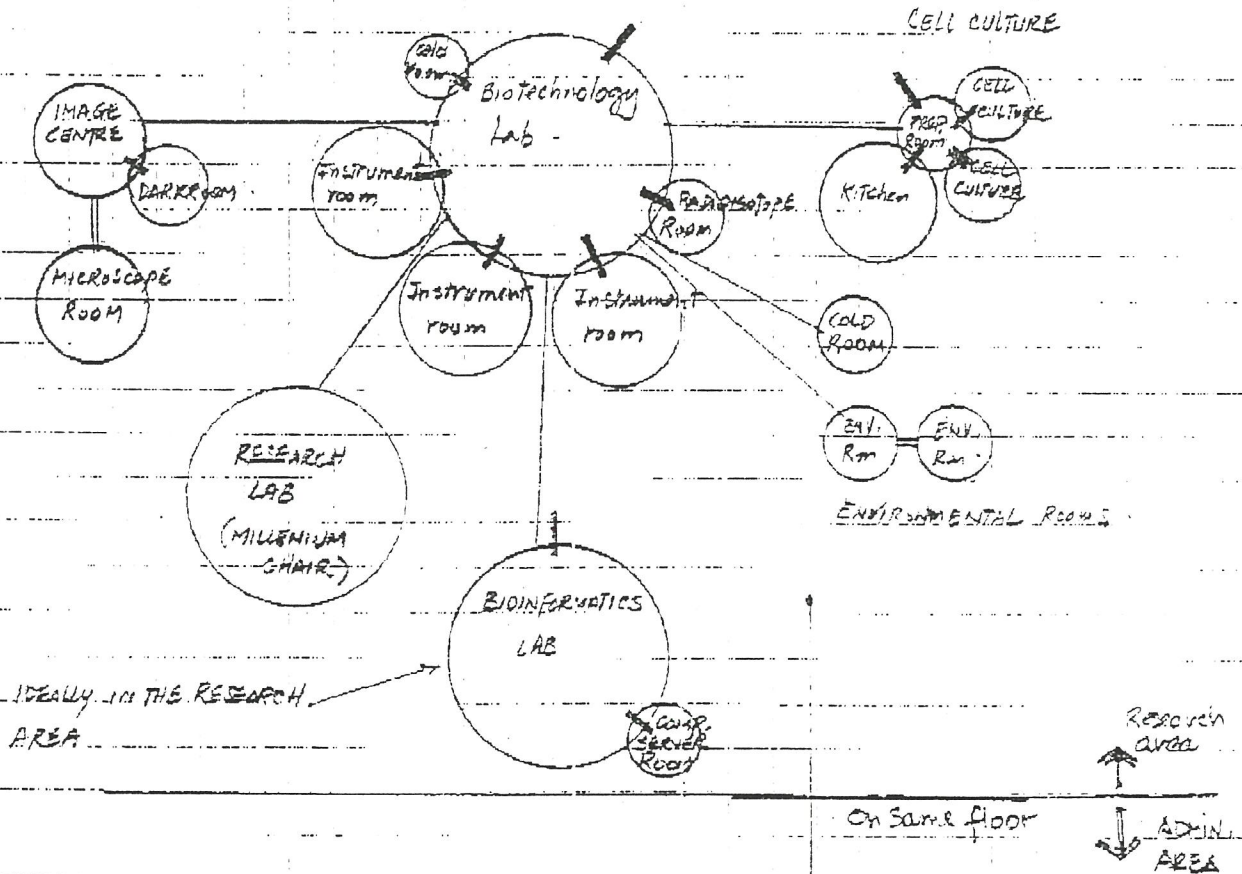
Total 735,5 Master Plan: 599 m²
-100 m² new bldg. =
499

~~217~~ -257

CENTRE FOR STRUCTURAL AND FUNCTIONAL GENOMICS

MAY 29, 2000

DRAFT FOR COMMENTS



LEGEND

- Entrance
- CONTIGUOUS, ACCESS THROUGH ROOM
- ADJACENT ROOMS
- ON SAME FLOOR

Appendix II

Discussion paper on Genomics at Concordia

Genomics at Concordia (Task Force Discussion Paper)

I. Research in genomics and proteomics

The dramatic growth in genomics-based research is driven by two complementary developments. The first is the advances that are being made in the technologies associated with studying biological systems, biotechnology. The second is the advances in the computer-based analysis of biological data, bioinformatics. To meet the challenges posed by the emerging science of genomics, an interdisciplinary group was formed at Concordia four years ago. This group now includes biologists, biochemists, chemists and computer scientists. The Centre for Structural and Functional Genomics was established in November 1998 to coordinate research activity in functional genomics which includes proteomics and part of structural genomics. In its first competition, the Canada Foundation for Innovation awarded two genomics grants in the Montreal region. The genomics centre at Montreal General Hospital will focus on structural genomics with a large sequencing facility. The Concordia facility will focus on functional genomics with the most advanced knowledge mining tools.

A. Research focus. Concordia will support and promote both basic and applied research programs. The research on genomics and proteomics will span fundamental investigations to industrial applications, and bioinformatics will play a critical role.

The basic research will focus on well characterized model organisms which are amenable to genetic manipulation. Much of our insights into gene function have been obtained by studying model organisms such as the bacterium *Escherichia coli*, the baker's yeast *Saccharomyces cerevisiae*, and the fruitfly *Drosophila melanogaster*. The development of leading edge technologies are also mainly derived from studies of model organisms. The first phase of the genome program aims at determining the genetic makeup of model organisms. The genomes of *E. coli*, *S. cerevisiae* and the soil nematode *C. elegans* have already been completed. Concordia researchers plan to use genomics-based approaches to determine gene function in the model organisms, with results expected to greatly enhance our understanding of how organisms function at the molecular level.

The applied research will primarily utilize microorganisms with significant impact on industry, human health and the environment. Microorganisms account for innumerable human, animal and crop diseases. On the other hand, many microorganisms have been widely used for food processing, production of biopharmaceuticals, and the degradation of hazardous waste. Current and proposed research includes the development of biopharmaceuticals, the screening of commercially valuable proteins, the identification of targets for drug design, and projects that have potential impact on food processing, agriculture, agri-food and the environment.

B. Research facility. The BioChem Pharma Genomics Facility will provide centralized infrastructure for various aspects of genomics and proteomics research. This facility will occupy 600 square metres of contiguous floor space in the proposed Science Complex. It comprises: 1) a biotechnology laboratory with two instrument rooms and bench space to accommodate 20 researchers; 2) a bioinformatics laboratory to house 20 workstations; 3) a cell technology

laboratory with three environmental rooms, two microscope rooms, and a photographic dark room; 4) a kitchen; 5) a conference/seminar room; and 6) a suite of offices for technical and secretarial staff.

Besides providing research support we expect the BioChem Pharma Genomics Facility will form a central point for intellectual interactions among researchers and research students. We propose that the Facility should be located in close proximity, if possible in the centre of, 15-20 research laboratories actively engaged in biotechnological research. As genomics and proteomics research are interdisciplinary by composition, the Genomics Facility will be well posited to provide conceptual and technical support for many other scientists at Concordia including behavioural neuroscientists and biodiversity researchers. Hence the laboratories of active researchers in these disciplines are best located close to the Genomics Facility.

As part of the arrangement with the Canada Foundation for Innovation, the genomics researchers will share the use of a high performance computer. This computer will be housed in the proposed Engineering/Fine Arts Building. The maintenance and management costs will be defrayed by the Faculty of Engineering and Computer Science.

II. Teaching and research training programs

Montreal is Canada's major centre for knowledge-based industries including pharmaceutical research, biotechnology and information technology. With the promise of sustained long-term economic growth, biotechnology and bioinformatics have become rapidly expanding industries. This has resulted in a severe shortage of qualified personnel in these fields. Recognizing that knowledge-based industry forms a key element to economic growth in this country, the federal and provincial governments have initiated proactive programs in the training and retaining of qualified personnel in the high technology areas. For example, Quebec is dramatically increasing the funding for training and research in high technologies.

Concordia has a reputation as a dynamic institution which has a talent of responding rapidly to the changing needs of the real world. It also has a mission of training graduates for the job market. Concordia is currently placed in an enviable position to have the resources, infrastructure and interdisciplinary research teams to contribute significantly to the emerging science of genomics and proteomics. With the momentum behind it, Concordia has the opportunity and responsibility to take a leadership role in the training of highly qualified personnel in these disciplines. Students will learn to work in an interdisciplinary environment, the forte of these programs, and will transfer this edge to their place of employment.

A. Ph.D. program

Brainpower is the driving force in knowledge industries. The bioscience industry needs personnel at the Ph.D. and postdoctoral levels. The rapid replacement of retiring faculty members in Canadian universities in the next 10-15 years will require personnel with postdoctoral training. A strong Ph.D. program is a prerequisite to meet the demands on highly qualified personnel. We propose to launch an interdisciplinary Ph.D. program in 3-5 years. Prior to the formation of the program, students engaged in research at the Ph.D. level will be enrolled in programs affiliated with their Ph.D. supervisors. The Ph.D. students are expected to take courses in the Msc program. However if we are to offer new program only at the Ph.D. level, we need to introduce at

least 6 new courses in bioinformatics and biotechnology.

The scarcity of graduate fellowships and suitable candidates are two factors limiting the expansion of a Ph.D. program in biotechnology and bioinformatics. To address the problem of graduate fellowships, we propose that the University targets a minimum of ten graduate fellowships to these areas. With a state-of-the-art infrastructure this will allow us to attract and retain outstanding Ph.D. candidates that far exceed the number of the fellowships available.

B. Graduate diploma and MSc programs

The computer science industries including bioinformatics normally seek BSc, diploma and MSc graduates. The technical positions in life science require MSc and diploma graduates. Flexible MSc and diploma programs will also be attractive to technical personnel interested in retraining. We propose a 30-credit diploma program and a 45-credit MSc program beginning in the year 2001. The 30 credit Diploma program is designed for university graduates with background in biology and biochemistry or with background in computer science. Students with work experience in relevant fields may enter this program without a formal bachelor degree. Upon completion of the Diploma, those with superior academic records who wish to pursue a 15-credit project may apply for admission to a 45 credit master's program.

Course requirements depend on the background and goal of the students. Students with background in biology and biochemistry who wish to obtain strong biotechnology training are required to take 21 credits in biotechnology, genomics and proteomics courses, 3 credits in basic computer science and 6 credits in bioinformatics. Students with background in biology and biochemistry who plan to focus on bioinformatics and computer analysis are required to take 15 credits in computer science courses chosen from the existing diploma program offered by the Department of Computer Science, 6 credits in bioinformatics, and 9 credits in genomics and proteomics. Students with computer science background who plan to pursue basic biotechnology and bioinformatics are required to take 12 credits of basic cell biology, genetics and chemistry, 6 credits in bioinformatics, and 12 credits in biotechnology, genomics and proteomics.

A total of 32 courses will be offered by these programs. Many of these courses can be taken by Ph.D. students to fulfill their course requirements. Twenty new courses, including 10 courses that will be cross-listed with the undergraduate programs, will be created. Eight courses will be modified from courses in our existing undergraduate programs, and 14 will be selected from existing courses in the Graduate Calendar.

C. Undergraduate programs

We expect most of the Ph.D. candidates to come directly from undergraduate programs instead of the diploma and MSc programs. Entry level positions in bioinformatics require BSc graduates. Also, an intensive program in biotechnology will prepare students adequately for entry level technical positions in life science industries, hospitals, and government and university laboratories.

We propose to offer beginning 2001 two undergraduate programs, one focuses on biotechnology and the other on bioinformatics. These programs will ideally be offered in a co-op scheme. Biotechnology majors will be required to take 24 credits in cell biology, molecular biology, analytical chemistry and biochemistry, 3 credits in computer science, 6 credits in

bioinformatics; 27 credits in biotechnology, genomics and proteomics; and 6 credits in independent project. Bioinformatics majors will be required to take 30 credits in computer science; 9 credits in bioinformatics; 15 credits in cell biology, molecular biology and biochemistry; 6 credits in biotechnology; and 6 credits in independent project. Each of these programs has a total of 66 credits.

Forty courses will be offered at the undergraduate level. Ten courses will be cross-listed with the graduate programs, sixteen are based on existing courses, six will be modified from existing courses, and eight will be new courses.

III. Administrative structure

The teaching programs in genomics and proteomics will operate as interdisciplinary programs under the joint jurisdiction of the Faculty of Arts and Science and the Faculty of Engineering and Computer Science. The day-to-day operation of the programs will be managed by the Centre for Structural and Functional Genomics. New hires in these programs will reside in one of the participating departments (Biology, Chemistry and Biochemistry, and Computer Science). Decision on hiring including the discipline, the departmental affiliation (with consultation with the Dean), and the formation of the hiring committee will be the responsibility of the Centre. In accordance with the Collective Agreement, new hires will have to be approved by the Departmental Personnel Committee and the Dean. However, mechanisms should be established such that the Centre will have significant input in the decision making on tenure and promotion of its members.

IV. Resource implications

Of the current faculty members 5-8 from the Department of Biology, 3-6 from the department of Chemistry and Biochemistry, 2-5 from the Department of Computer Science are expected to participate in interdisciplinary research and teaching in genomics. However the teaching of core courses in existing programs remains the responsibility of this group; e.g. the Cell and Molecular program, and the Biochemistry program. Thus for new courses developed by this group we need to hire new faculty members to participate in the teaching of the new courses and/or cover the existing courses left open by current members. Also, we plan to offer 6 new lab courses in biotechnology and bioinformatics. New laboratories, technicians and teaching assistants are required to accommodate the lab courses.

All faculty members involved in these programs are expected to be active researchers, and they will be teaching 9 credits per year. They will also require space for their offices and students. Approximately 100 square metres are for office and lab space for each new faculty and his/her students.

Summarized below are the various options and resource implications needed to offer the new programs. Laboratory courses at the graduate level will be run in the form of workshops, and they make extensive use of the bioinformatics and biotechnology laboratories of the BioChem Pharma Genomics Facility. The estimation of space requirement below takes into account the usage of the Genomics Facility and undergraduate laboratories in the participating departments.

Table 1. Summary of programs and resource implications

Program	Introduction date	Expected enrolment	# of new courses	# of new personnel	Space (m ²)
PhD	2002-4	25	6	2 faculty 10 fellowships	200
MSc/Diploma	2001	60	20	6-7 faculty 1 new lab 2 technicians 1 secretary	800
BSc	2001	150-200	18	6 faculty 2 new labs 2 technicians 1 secretary 8 TAs	900
PhD + MSc/Diploma	2001/2002	25/60	20	6-7 faculty 1 new lab 2 technicians 1 secretary 10 fellowships	800
MSc/Diploma + BSc	2001	60/150-200	28	9 faculty 3 new labs 3 technicians 2 secretaries 8 TAs	1350
PhD + BSc	2001/2002	25/150-200	21	7 faculty 2 new labs 2 technicians 1 secretary 10 fellowships	1000
PhD + MSc/Diploma + BSc	2001/2002	25/60/150-200	28	9 faculty 3 new labs 3 technicians 2 secretaries 10 fellowships 8 TAs	1350

Programs

MASTER WITH THESIS

Students must successfully complete Master's research and thesis (30 credits) and take a total of 15 credits of 600-level courses including 6 credits in bioinformatics and 3 credits in instrumentation.

MASTER WITH MAJOR REPORT

Students are required to successfully complete the Diploma program and master's project and report (15 credits).

DIPLOMA

The 30 credit Diploma program is designed for university graduates with background in biology and biochemistry or with background in computer science. Upon completion of the Diploma, those with superior academic records who wish to pursue a 15 credit project may apply for admission to a 45 credit master's program.

Course requirements depend on the background and goal of the students. Students with background in biology and biochemistry who wish to obtain strong biotechnology training are required to take COMP 501, BIOL 647, BIOL 672, BIOL 673, and a minimum of 6 credits in BCC 6xx, 3 credits in 600-level Biotechnology (in addition to BIOL 647), and 3 credits in CHEM 6xx. Students with background in biology and biochemistry who plan to focus on bioinformatics and computer analysis are required to take COMP 501, COMP 520, COMP 536, COMP 542, COMP 546, COMP 551, COMP 553, COMP 554, and 6 credits in BCC 6xx. Students with computer science background who plan to pursue basic biotechnology and bioinformatics are required to take BIOL 561, BIOL 566, BIOL 568, BIOL 570, BIOL 571, CHEM 505, CHEM 571, and 6 credits in BCC 6xx.

CERTIFICATE

The 15 credit Certificate program is for biotechnologists who wish to upgrade their skills. Students in the Certificate program may apply for admission to the Diploma program at any time.

Students are required to take a minimum of 3 credits in BCC 6xx, 3 credits in block A (BIOL 647, BIOL 677, BIOL 678, CHEM 6xx), 3 credits in block B (CHEM 631, BIOL 671, BIOL 672) and 3 credits in block C (BIOL 641, BIOL 642, BIOL 643, BIOL 644, CHEM 678).

Courses

Biology

- BIOL 561^b Genetic Analysis (modified BIOL 261)
- BIOL 566^b Molecular Biology of the Cell (modified BIOL 261)
- BIOL 568^b Gene Activity (modified BIOL 468)

Chemistry

- CHEM 505^b Chemical Basis of Life (general chemistry)
- CHEM 571^b Biochemistry of Protein and Nucleic Acids
- CHEM 631^a Computational Chemistry

Computer Science

- COMP 501^a Computer Programming (similar to COMP 248)
- COMP 520^a Computer Organization and Assembly Language
- COMP 536^a Discrete Structures and Formal Languages
- COMP 542^a Object Oriented Programming
- COMP 546^a Operating Systems
- COMP 551^a Principles of Data Structures
- COMP 553^a Files and Databases
- COMP 554^a Tools and Techniques for Software Engineering

Bioinformatics

- BCC 6xx^c Essential Bioinformatics
- BCC 6xx^c Bioinformatics Laboratory
- BCC 6xx^{cd} Molecular Modeling
- COMP 651^a Database Design
- COMP 659^a Introduction to Knowledge-Base System
- COMP 663^a Discrete System Simulation
- COMP 672^a Introduction to Artificial Intelligence

Biotechnology

- BIOL 570^c Basic Biotechnology (techniques, applications, social and ethical issues)
- BIOL 571^b Biotechnology Laboratory (modules from BIOL 368 and BIOL 466)
- BIOL 641^{cd} Microbial Biotechnology
- BIOL 642^{cd} Medicinal Biotechnology
- BIOL 643^{cd} Environmental Biotechnology
- BIOL 644^{cd} Agriculture and Agri-Food Biotechnology
- BIOL 647^c Recombinant DNA Laboratory

Genomics

- BIOL 672^{cd} Structural Genomics
- BIOL 673^{cd} Functional Genomics
- BIOL 677^c Genomics laboratory
- BIOL 678^c High-throughput Instrumentation

Proteomics

- CHEM 6xx^c Biological Mass Spectrometry
- CHEM 6xx^c Proteomics Laboratory
- CHEM 678^a Protein Engineering and Design
- CHEM 679^a Protein Structure and Dynamics

BACHELOR OF SCIENCE

Students entering this program are expected to have completed CEGEP biology and organic chemistry courses. Students are required to take 15 credits of Biology courses, 9 credits of Chemistry courses, 18 credits in the Computer Science Core, and a minimum of 6 credits in Intermediate and Advanced Computer Science, 6 credits in Biotechnology, 6 credits in Bioinformatics, 6 credits in genomics and proteomics, and 6 credits in independent project for a total of 72 credits.

Courses

Biology

BIOL 261 ^a	Molecular and General genetics
BIOL 266 ^b	Cell Biology (re-organized with topics from BIOL 364)
BIOL 367 ^a	Molecular Biology
BIOL 368 ^a	Genetics and Cell Biology Laboratory
BIOL 466 ^a	Advanced Laboratory in Molecular Biology

Bioinformatics

BIOL 481 ^c	Bioinformatics I
BIOL 482 ^c	Bioinformatics II
CHEM 482 ^{cd}	Molecular Modeling

Biotechnology

BIOL 443 ^{cd}	Environmental Biotechnology
BIOL 444 ^{cd}	Agriculture and Agri-Food Biotechnology
BIOL 445 ^{cd}	Microbial Biotechnology
BIOL 446 ^{cd}	Medicinal Biotechnology

Chemistry and Biochemistry

CHEM 212 ^a	Analytical Chemistry
CHEM 271 ^a	Biochemistry I
CHEM 375 ^b	Biochemistry II (focus on protein and nucleic acids)

Computer Science Core

COMP 228 ^a	System hardware
COMP 229 ^a	System Software
COMP 238 ^a	Mathematics for Computer Science I
COMP 239 ^a	Mathematics for Computer Science II
COMP 248 ^a	Introduction to programming
COMP 249 ^a	Programming Methodology
COMP 352 ^a	Data Structure and Algorithms

Intermediate and Advanced Computer Science

COMP 352 ^a	Databases
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COMP 354^a Software Engineering
COMP 451^a Database design
COMP 463^a Discrete System Simulation
COMP 471^a Computer Graphics
COMP 472^a Artificial Intelligence

Genomics and Proteomics

BIOL 472^{cd} Structural Genomics
BIOL 473^{cd} Functional Genomics
CHEM 415^a Analytical Separation
CHEM 494^a Mass Spectrometry

a, existing courses

b, existing courses with substantial modifications

c, new courses

d, cross-listed courses (between undergraduate and graduate programs)